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An Assessment of the Academic Impact of Shock Society Members

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Abstract

Professional society membership enhances career development and productivity by offering opportunities for networking and learning about recent advances in the field. The quality and contribution of such societies can be measured in part through the academic productivity, career status, and funding success rates of their members. Here, using Scopus, NIH RePORTER and departmental websites, we compare characteristics of the Shock Society membership to those of the top 55 NIH-funded American university and hospital-based departments of surgery. Shock Society members' mean number of publications, citations and H-indices were all significantly higher than those of non-members in surgery departments ($p<0.001$). A higher percentage of members also have received funding from the NIH (42.5% vs. 18.5%, $p<0.001$). Regression analysis indicated that members were more likely to have NIH funding compared to non-members (OR 1.46, 95%CI 1.12–1.916). Trauma surgeons belonging to the Shock Society had a higher number of publications and greater NIH funding than those who did not (130.4 vs. 42.7, $p<0.001$; 40.4% VS. 8.5%, $p<0.001$). Aggregate academic metrics from the Shock Society were superior to those of the Association for Academic Surgery and generally for the Society of University Surgeons as well. These data indicate that the Shock Society represents a highly academic and productive group of investigators. For surgery faculty, membership is associated with greater academic productivity and career advancement. While it is difficult to ascribe causation, certainly the Shock Society might positively influence careers for its members.

Keywords

Academic Productivity; H-index; NIH funding; Trauma Surgery; Citations

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INTRODUCTION

The Shock Society was founded in 1977 to integrate basic and clinical study of the pathophysiology and treatment of trauma, shock, and sepsis, as well as promote awareness of these conditions (1, 2). Given our recent study identifying a decrease in the academic productivity in trauma, surgical critical care and acute care surgery (ACS) faculty (3, 4), we aimed to evaluate whether this concerning trend extends to the members of the SHS.

Academic productivity may refer to both the quantity and quality of scientific output in the clinical and basic science realms (5). High academic productivity portends success and promotion for faculty at university programs (6, 7). Several objective measures of academic productivity have been validated and are frequently used to this aim. While more complicated measures exist, and others are being developed, number of publications, number of citations, and H-index are routinely used across scientific, medical, and surgical specialties (8–12). The H-index is a function that seeks to quantify an author's relative quality by integrating his or her prolificacy and citation impact. Research funding, particularly from the National Institutes of Health (NIH), and in the case of trauma research, the Department of Defense, is a further sign of academic excellence (8, 13, 14).

Herein, we posited that academic productivity problems that are present in acute care surgery (ACS) and trauma surgery nationwide are less severe within the SHS membership because its members generally maintain active basic or translational research efforts. We therefore evaluated the academic productivity of Shock Society members and compared them to our previously published dataset of 4,286 academic surgeons (15). A comparison by H-index, number of publications, number of citations, academic rank, academic leadership, NIH funding, and degrees between Shock Society members and non-members was performed. We also characterized the productivity of comparable groups, including trauma surgeons, basic science researchers within surgery departments, and non-trauma surgeons, between these datasets. These data support that the SHS members are academically excellent, are advancing research in the field of trauma, shock and sepsis, as well as functioning as a highly academically productive faculty in their respective fields and departments.

METHODS

This study is a retrospective cross-sectional study comparing the academic performance of Shock Society members to faculty in academic departments of surgery in the United States.

Data Collection and Verification

As previously reported in our other works (4, 15–17), we identified the top 55 NIH-funded departments of surgery using the rankings from the Blue Ridge Institute for Medical Research. Each institution's department of surgery website was individually accessed, and demographic information was recorded, including faculty member's name, sex, division, academic rank, degrees, and information regarding career track. The 2015 Shock Society membership directory was obtained. The database was then populated with publication, citation, and H-index data obtained from the SCOPUS website (www.scopus.com) accessed

through Indiana University Purdue University Indianapolis's institutional account (summer, 2016). We cross-matched current and former institutional affiliations prior to incorporating SCOPUS data to maximize accuracy. NIH funding data were obtained through the NIH Research Portfolio Online Reporting Tools (RePORT) website (www.report.nih.gov) and Grantome (www.grantome.com). NIH grant funding was determined by whether the faculty member had funding or not, and whether the faculty member had a R01, U01, or P01 grant or not. We were not able to include Department of Defense grants, which are important funding sources for trauma and critical care faculty, but are not readily searchable. Our initial data collection yielded 4,286 faculty members, of whom 409 belonged to the Shock Society. Publications for authors not readily available in SCOPUS were manually calculated or queried through the use of alternative names. All parameters of 30% of the data were rechecked by another coauthor after completion of the database. Using this two-investigator verification process yielded fewer than 1/500 errors of variables in the database (4, 15).

Statistical Analyses

Descriptive statistics were calculated on the data set deriving overall mean and median publications, citations and H-indices using IBM SPSS Statistics for Windows version 23.0 (SPSS, Chicago, IL). Comparisons were performed in different subgroups of the data set including academic rank, divisional leadership positions, degrees, and NIH funding history. Based upon divisional affiliation, surgery faculty members were divided into three groups for this study: 1) trauma surgery, critical care, and acute care surgery (ACS); 2) non-clinical/basic science/research; and 3) surgeons from other subspecialties. PhD faculty members were collected into group 2. We then compared demographic characteristics and scholarly output of Shock Society members and non-members within these groups. Comparisons were made using the Student t-test and chi square tests (SPSS). Multivariable logistic regression was performed to assess the association between Shock society membership and NIH funding, while controlling for academic rank (assistant, associate, full professor), degree type (MD, PhD, MD/PhD), gender, and H-index (SPSS). Comparisons to the Association for Academic Surgery and the Society of University Surgeons used reported aggregate data (13, 15), with one-way ANOVA for publications, citations, and H-index, and chi-squared and Fisher's exact tests for all other comparisons using Prism 7.0a (GraphPad Software, Inc., LaJolla, CA).

RESULTS

Overview of Demographics and Academic Output of Shock Society Members and Non-Members

We identified 409 Shock Society members and 3,877 non-members. Members and non-members were equal for gender, with 24.4% and 21.7% women respectively ($P = 0.196$). Of members, approximately half had an MD, with approximately one quarter of members either being a PhD or MD-PhD. As expected, non-member surgery faculty were largely MDs, with approximately 90% MD and 5% MD-PhD. Our analysis included all Shock Society members, included almost 15% who were students, fellows or other/unknown rank versus <5% in the non-member group. Overall, however, Shock Society members tended to have a higher academic rank than non-members. Shock Society members were also three times

more likely to be department or section chairs or have other major leadership positions. Members had almost twice the number of any or large (R01, U01, or P01 grants) NIH grants. Members also had roughly double the number of publications, citations, and H-indices than non-members (P <0.001) (Table 1).

Evaluation of Academic Productivity Based on Specialty of Shock Members and Non-Members

We further compared the academic productivity of Shock Society members based on their training backgrounds to determine if one particular subset of members is driving the academic productivity of the society. We compared three cohorts of Shock Society members to their non-member equivalents: (1) trauma, critical care, and ACS faculty (Table 2), (2) non-clinical faculty and basic science researchers (Table 3), and (3) clinical faculty in specialties other than trauma, critical care, and ACS (Table 4).

We identified 156 SHS members and 612 non-members in the trauma, critical care, and ACS cohort (Table 2). The gender breakdown was statistically equivalent. There was a three-fold higher percentage of members with MD-PhD degrees. Overall, considerably more members were full professors or emeritus professors. The Shock Society members in this cohort were almost four times more likely to be in a leadership position compared to non-members and demonstrated a considerably greater NIH-funding rate. Finally, members had substantially more publications, citations, and higher H-indices compared to non-members.

The basic science cohort had 135 SHS members and 296 non-members (Table 3). While there were a higher proportion of female members and non-members in basic science than in the clinical cohorts, the two groups within the comparison were equivalent for gender. Again, members were more likely to be full or emeritus professors, to be in a position of leadership, and to have NIH funding. Similarly, members also had significantly more publications, more citations, and higher H-indices compared to non-members.

The final cohort we compared were the clinical faculty in specialties other than trauma, critical care, and acute care surgery (Table 4). There were 118 Shock Society members and 2969 non-members in this cohort. These comprised the majority of non-members in our control group. The fraction of women was similar between groups at about one quarter. A much higher percentage of Shock Society members had MD-PhDs and a lower percentage had MDs. Shock Society members were more likely to be in Ieadership positions and to be NIH funded, and had substantially more publications and citations (Table 4).

Factors associated with NIH Funding

We performed an analysis to determine to what attributes were associated with NIH funding among all faculty, members and non-members alike (Table 5). A PhD degree was highly associated with NIH funding, as was an MD/PhD, with odds ratios of 5.0 and 1.9, respectively, compared to MD alone (P <0.0001). Full professorship and associate professorship were both approximately twice as likely to be NIH funded compared to assistant professors. Gender was not associated with different rates of NIH funding. Each unit increase in the H-index increased the likelihood of NIH funding by 6.3%. Finally,

Shock Society membership was associated with higher rates of NIH funding compared to non-membership.

Comparison with other academic surgical societies

Not all of the members of the Shock Society are surgeons or affiliated with departments of surgery, although many are. Moreover, the mission of the Shock Society encompasses many surgically-relevant questions. We compared the characteristics of the Shock Society with those of the Association for Academic Surgery (AAS) and the Society of University Surgeons (Table 6). Criteria for membership of these societies differ, which is important ways for this analysis. The Shock Society accepts members at all stages of training and professional status from students on up the academic ladder. In contrast, active AAS members are surgeons from chief resident to faculty within 10 years of their first faculty appointment, and SUS membership is bestowed only to well-established professionals with demonstrated scholarly or other creative ability. Types of degrees were not different between AAS and SUS memberships, but both were more likely to hold MD degrees versus Shock Society members (93.5% and 90.1% versus 54.8%). PhDs were under-represented among the AAS and SUS compared with the Shock Society (5.5% and 8.8% versus 23.2%), while MD-PhDs constituted only 1.1% of AAS and SUS, but 19.6% of Shock Society ($P<0.0001$). Academic rank was higher in the SUS, as expected, with greater proportions of professor/emeritus professors (67.7%) than in the AAS (43.6%). Compared with the AAS, the Shock Society showed fewer faculty-level members overall, although rates of full professors were similar. Leadership positions were less frequent among members of the AAS than the SUS (15.8% vs 23.5%, $P<0.001$); Shock Society members were more likely to be leaders (45.2%) than either AAS or SUS ($P<0.0001$, both). Frequency of NIH funding of any sort was significantly lower in the AAS (13.9%) than in the SUS (49.4%) or the Shock Society (42.8%) ($P<0.0001$). The difference between SUS and Shock approached significance (0.053). For R01/U01/P01 funding, and numbers of citations, the SUS demonstrated greater numbers than AAS, and the Shock Society demonstrated greater numbers than either of the other two. Total numbers of publications were lower in AAS than SUS or Shock Society, but were not different between the SUS and Shock Society. A difference in H-indices could not be identified across societies, although the difference among the three groups reached $P=0.0404$.

DISCUSSION

These data demonstrate that the Shock Society is a preeminent group of academic investigators. Overall, members show strong academic performance that outpaces non-members. Members outperform non-members in every measured variable: degree, academic rank, leadership, NIH funding, size of NIH grant, numbers of publications and citations, and H-index. Of the three cohorts evaluated, basic scientists led with the most NIH funding. However clinical faculty in the Shock Society had comparable publications, citations, and H-indices to the basic science members. Furthermore, Shock Society members among trauma, critical care, and acute care surgery faculty were more academically productive than their non-member peers.

Our previous research has demonstrated that young trauma and ACS surgeons are lagging behind their peers in other surgical subspecialties as well as senior faculty in academic productivity (3, 4). They have less current and former NIH funding, fewer publications and citations, and lower H-indices (4). Trauma and ACS surgeons have experienced an increase in various responsibilities over the past 20 years, including administration, education, and service (18). These faculty members might be spending non-clinical time differently than in the past, with more junior faculty members attracted to lifestyle aspects of the career and fewer engaging in research outside the operating room (19, 20). As well, although trauma and acute surgical disease comprise a large burden on the health care system, NIH funding is not proportionately granted, which might both highlight and cause a diminution in quality trauma or surgery research (13, 14).

The Shock Society has the stated mission to promote “the education and mentoring of the next generation of investigators in the field of trauma, shock, and sepsis.” Consistent with mission success, these data show that the Shock Society membership bucks the overall trend of decreasing academic productivity in the trauma field. As well, Shock Society membership associates with NIH funding, as demonstrated by our multivariable analysis. That same analysis also indicates that being in a leadership position does not associate with NIH-funding (3, 4).

There are clear limitations to this study. This is necessarily a retrospective study, which can only give a view of the Shock Society’s productivity at a fixed time, without the ability to examine trends. While every effort was made to ensure the integrity of the data, a few faculty members might have been missed in our searches. Furthermore, affiliations of faculty members are frequently changing, and thus this may not be reflected in this analysis. However, in order to minimize inaccuracies in the data, two investigators independently reviewed a sampling of the dataset and two statistical analyses were carried out. NIH funding could be verified through NIH RePORTER, but Department of Defense award data, which are important to surgery, trauma, and injury research, were not available. Also, publications and citations provide only a crude measure of academic productivity, particularly when authorship contributions cannot be accurately captured. SCOPUS is limited in that it does not distinguish the hierarchy of authorship; thus, we did not provide weight to first-authorship over second- or senior-authorship, for instance. Moreover, academic productivity, quality, and quantity are multifaceted, and can be difficult to compare across specialties. We do use validated objective measures, such as funding, number of publications and citations, and H-index, which are frequently used to evaluate faculty for promotion (6, 9–12, 15); however, they do not capture mentorship, time, and resources available for academic pursuits, etc.

Comparative analysis with the AAS and SUS showed superiority of the Shock Society for many metrics. It is likely that there is some overlap in membership between the societies, although the Shock Society has preferentially larger fractions of PhDs and MD-PhDs, indicating substantial non-overlapping populations as well. We have shown previously that PhDs in academic surgery demonstrate higher academic productivity and funding success than their MD colleagues, regardless of departmental ranking, and moreover, they seem to generate a halo effect of lifting overall departmental success (21). Thus, one explanation for

the generally higher metrics of the Shock Society could be due to the higher rates of included PhDs and MD-PhDs.

Of course, this is an associative study and causation cannot be concluded; i.e. Shock Society membership might not drive academic productivity and funding. Rather those metrics might determine who joins the Shock Society. Unlike the AAS and SUS, however, membership in the Shock Society is not predicated on rank or achievement, and is open to students, residents, fellows and other trainees as well as faculty of all ranks. Thus, it is possible that its high productivity is less of a self-fulfilling prophecy than that of explicitly senior societies such as the SUS. And so, it is possible that the Shock Society does go some ways toward meeting its stated missions of promoting clinically relevant research into the basic biology of trauma, shock, and sepsis; providing a multidisciplinary forum to integrate and disseminate new knowledge in trauma, shock, and sepsis; and promoting the education and mentoring of the next generation of investigators in the field of trauma, shock, and sepsis. Members can access the Society's journal, annual meetings (22, 23), travel awards, grants, educational workshops and fellowships (24), network with national and international experts and colleagues (25, 26), as well as participate in debates and alliances that define the most important experimental questions and effective approaches in the field (27–29). Therefore, alignment with the Shock Society could facilitate career development and academic impact.

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Table 1

Comparison of all Shock Society members with non-member academic surgical faculty

Overall	Shock Society members N = 409	Non–members N = 3877	*P*
Gender			0.196
Female	100 (24.4)	840 (21.7)	
Male	309 (75.6)	3037 (78.3)	
Degree			**<0.001**
MD	224 (54.8)	3433 (88.5)	
PhD	95 (23.2)	238 (6.1)	
MD-PhD	80 (19.6)	201 (5.2)	
Others	10 (2.4)	5 (0.1)	
Academic Rank			**<0.001**
Instructor	4(1.0)	133 (3.4)	
Assistant	74 (18.1)	1426 (36.8)	
Associate	80 (19.6)	917(23.7)	
Professor/Emeritus	195 (47.7)	1229 (31.7)	
Unknown/Other	56 (13.7)	172 (4.4)	
Leadership	185 (45.2)	607 (15.7)	**<0.001**
NIH Funding (+)	175 (42.8)	713 (18.4)	**<0.001**
R01/U01/P01 (+)	125 (30.6)	384 (9.9)	**<0.001**
Publications	122 ± 158	63 ± 186	**<0.001**
Citations	3859 ± 6724	1530 ± 3016	**<0.001**
H-index	25 ± 201	14 ± 13	**<0.001**

Table 2

Comparison for Trauma/Acute Care Surgery/Surgical Critical Care, Shock Society members versus non-members.

Trauma/Acute Care Surgery/Surgery Critical Care	**Shock Society members N = 156**	**Non–members N = 612**	***P***
Gender			
Female	25 (16.0)	126 (20.5)	0.201
Male	131 (84.0)	486 (79.4)	
Degree			**<0.001**
MD	136 (87.2)	588 (96.1)	
PhD	0	0	
MD-PhD	19 (12.2)	24 (3.9)	
Others	1 (0.6)	0	
Academic Rank			**<0.001**
Instructor	1 (0.6)	28 (4.6)	
Assistant	30 (19.2)	248 (40.5)	
Associate	31 (19.9)	144 (23.5)	
Professor/Emeritus	80 (51.3)	166 (27.1)	
Unknown/Other	14 (9.0)	26 (4.2)	
Leadership	87 (55.8)	92 (15.0)	**<0.001**
NIH Funding (+)	52 (33.3)	63 (10.3)	**<0.001**
R01/U01/P01 (+)	32 (20.5)	25 (4.1)	**<0.001**
Publications	130 ± 163	43 ± 75	**<0.001**
Citations	3943 ± 6654	997 ± 2190	**<0.001**
H-index	26 ± 20	10 ± 11	**<0.001**

Table 3

Comparison for Non-Clinical/Basic Science/Research, Shock Society members versus non-members.

Non-Clinical/Basic Science/Research	**Shock Society members N = 135**	**Non–members N = 296**	***P***
Gender			0.81
Female	49 (36.3%)	111 (37.5)	
Male	86 (63.7)	185 (62.5)	
Degree			**0.001**
MD	16 (11.9)	39 (13.2)	
PhD	95 (70.4)	238 (80.4)	
MD-PhD	18 (13.3)	18 (6.1)	
Others	6 (4.4)	1 (0.3)	
Academic Rank			**<0.001**
Instructor	3 (2.2)	10 (3.4)	
Assistant	19 (14.1)	118 (39.9)	
Associate	27 (20.0)	89 (30.1)	
Professor/Emeritus	64 (47.4)	75 (25.3)	
Other/Unknown	22 (16.3)	4 (1.4)	
Leadership	48 (35.6)	25 (8.5)	**<0.001**
NIH Funding (+)	76 (56.3)	136 (45.9)	**0.046**
R01/U01/P01 (+)	62 (45.9)	96 (32.4)	**0.007**
Publications	128 ± 159	69 ± 96	**<0.001**
Citations	4706 ± 7818	2045 ± 2981	**<0.001**
H-index	28 ± 22	18 ± 13	**<0.001**

Table 4

Comparison for Clinical Non-Trauma, Shock Society members versus non-members.

Clinical Non-Trauma/Non-ACS/Non-Surgery Critical Care	**Shock Society members N = 118**	**Non–members N = 2969**	***P***
Gender			0.648
Female	26 (22.0)	603 (20.3)	
Male	92 (78.0)	2366 (79.7)	
Degree			**<0.001**
MD	72 (61.0)	2806 (94.5)	
PhD	0	0	
MD-PhD	43 (36.4)	159 (5.4)	
Others	3 (2.5)	4 (0.1)	
Academic Rank			**<0.001**
Instructor	0	95 (3.2)	
Assistant	25 (21.2)	1060 (35.7)	
Associate	22 (18.6)	684 (23.0)	
Professor/Emeritus	51 (43.2)	988 (33.3)	
Other/Unknown	20 (16.9)	142 (4.8)	
Leadership	50 (42.4)	490 (16.6)	**<0.001**
NIH Funding (+)	46 (390)	514 (17.3)	**<0.001**
R01/U01/P01 (+)	31 (26.3)	263 (8.9)	**<0.001**
Publications	104 ± 150	66 ± 208	**0.049**
Citations	2768 ± 5181	1589 ± 3151	**<0.001**
H-index	21 ± 19	15 ± 14	**<0.001**

Table 5

Adjusted Odds for NIH Funding among U.S. Departments of Surgery Faculty

	Odds Ratio	95% Lower Confidence Limit	95% Upper Confidence Limit	*P*
Degree Type				**<0.0001**
MD	*Reference*			
PhD	**5.009**	**3.78**	**6.639**	
MD/PhD	**1.936**	**1.426**	**2.629**	
Academic Rank				**<0.0001**
Assistant	*Reference*			
Associate	**1.712**	**1.312**	**2.234**	
Professor	**2.157**	**1.651**	**2.819**	
Gender				0.6853
Male	*Reference*			
Female	1.049	0.833	1.321	
H-Index	**1.063**	**1.055**	**1.071**	**<0.0001**
Shock Membership			**0.0065**	
Non-Member	*Reference*			
Member	**1.459**	**1.112**	**1.916**	

Table 6

Comparison of the Association for Academic Surgery (AAS), the Society of University Surgeons (SUS), and the Shock Society memberships

	AAS[a] N = 824	**SUS[b] N = 502**	**Shock Society[c] N = 409**	***P* Overall**	**Significant Differences**
Degree				**<0.001**	**<0.0001[a–c, b–c]**
MD	770 (93.5%)	452 (90.1)	224 (54.8)		
PhD	45 (5.5)	44 (8.8)	95 (23.2)		
MD-PhD	9 (1.1)	5 (1.1)	80 (19.6)		
Other	0	0	10 (2.4)		
Rank				**<0.001**	**<0.0001[a–b, b–c]** **<0.001[a–c]**
Assistant	247 (30.0)	36 (7.3)	74 (18.1)		
Associate	217 (26.3)	125 (24.9)	80 (19.6)		
Professor/Emeritus	359 (43.6)	339 (67.7)	195 (47.7)		
Leadership	130 (15.8)	117 (23.5)	185 (45.2)	**<0.001**	**<0.001[a–b]** **<0.0001[a–c, b–c]**
Any NIH funding (+)	115 (13.9)	248 (49.4)	175 (42.8)	**<0.0001**	**<0.0001[a–b, a–c]** 0.053[b–c]
R01/U01/P01 (+)	110 (13.4)	91 (18.1)	125 (30.6)	**<0.0001**	**0.022[a–b]** **<0.0001[a–c, b–c]**
Publications	54 ± 96	112 ± 150	122 ± 158	**<0.0001**	**<0.0001[a–b]** **<0.0001[a–c]**
Citations	985 ± 3321	2460 ± 4849	3859 ± 6724	**<0.0001**	**<0.0001[all]**
H-Index	13 ± 15	25 ± 15	25 ± 201	**0.0404**	none

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